Space Weather Technical Forecast

Issued on Sunday, 13 August 2023 at 01:11 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Peak Chance of G1 Monday 14 August UTC, perhaps with a lesser peak midweek. Chance of R1 throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity, as measured at GOES16 has been Low through the UTC day of Saturday 12 August, with the peak flare observed a C8.8 at 012/0915UTC from AR3395 in the northwest.

There are now up to five active regions on the disc, as although a new unnumbered bipolar region has developed in the southwest, a couple of unipolar candidates for regions faded. The most complex region on the disc remains AR3395, with up to three delta spots, however this has decayed areally and is now showing signs of simplification, although it remains a Dac/Beta-Gamma-Delta at the time of writing. AR3397 to its east, meanwhile, has developed more spots in the period, particularly in its trailing regions, to become a Dai/Beta. Finally, AR3394 in the southeast showed decay in its minor spots to leave its long-term one main penumbral spot unaccompanied as an Hhx/Alpha.

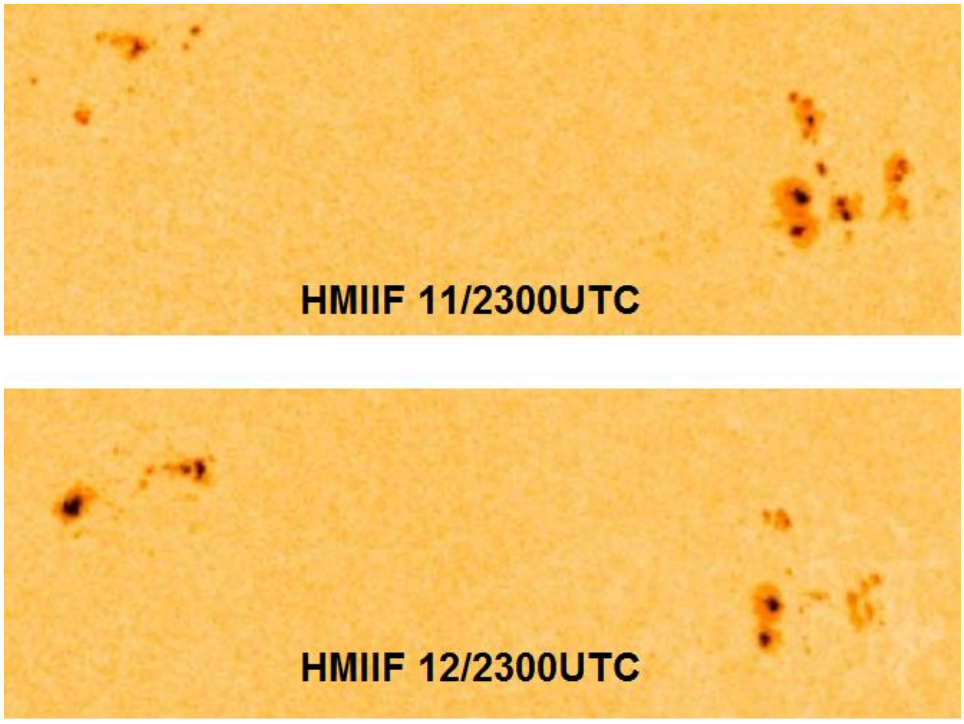

Figure 0: 24-hour growth/decay trend in AR3397 (right) and AR3395, showing an approach towards equalising their potency (on paper). AR3395 does however retain some much-weakened Mt Wilson delta spot candidates, in contrast to its neighbour.

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While there were some Coronal Mass Ejections (CMEs) visible on coronagraphs in the period, these mainly appear to be linked with the far-side western hemisphere to no effect at Earth. No CMEs are thought to be en route at present.

Solar Wind / Geomagnetic Activity: Solar winds, as observed at ACE at L1, remained slightly elevated, most likely the result of a weak connection to a minor negative polarity coronal hole. While the source is not clear from EUV imagery, the geomagnetic effect in any case has been largely inconsequential.

The phi angle was towards the Sun (negative) throughout. The solar wind speed started the 24 hours at around 450 km/s, with a slight waning observed with time to finish nearer 400km/s. The solar wind density was within its long-term average in single figures ppcc. The IMF was within its typical background range, falling slightly from an early high near 7nT, with a smoother character developing as the day went on. The north-south component ranged from +6 to -5nT, with no protracted periods either aligned or anti-aligned with Earth's field.

The net result of the above solar wind measures was Quiet geomagnetic activity throughout, with provisional Kp values peaking at '2+' in the 03-06UTC interval.

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux continued erratically easing, very roughly from 0.5 to nearer 0.25pfu, i.e. very near resting background levels. This enhancement was due to the 07 August X1.5 flare from Ex-AR3386 (now diametrically opposite the Earth on the far side of the Sun).

High energy (greater than 2MeV) electron flux at GOES16 ranged from Normal Background levels to High, on a slightly attenuated diurnal oscillation that peaked at 1003pfu at 12/1530UTC. The associated 24-hour integrated fluence remained below the Active level (1e8 integrated pfu), recording 4.16e7 integrated pfu at 13/0001UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: There is a daily chance of isolated M-class flares, perhaps most likely from AR3395 in the northwest. Two of the current front-sided regions are due to depart midweek (UTC), and as such a slight reduction in risk is forecast, with any compensatory arriving sunspot regions from the eastern solar horizon yet to manifest.

Solar Wind / Geomagnetic Activity: There are no Earth-directed CMEs. The next fast wind enhancement is expected to be from the arrival of the HSS of CH33/+, most likely on day 2 (Monday 14 August) with speeds potentially reaching near 500km/s. Initially mainly Quiet geomagnetic activity should give way to a Chance of G1 Minor Storm intervals, with the risk of this peaking on Monday. A transition to a negative polarity coronal hole CH34/- is then a possibility on Wednesday 16 August, with a secondary Slight Chance of G1 due to the lesser stature of the hole as well as its polarity.

Energetic Particles / Solar Radiation: No solar radiation storms are expected, with the high-energy proton flux expected to soon reach resting Background, with only a slight chance of rising in response to any flares from the most complex region(s).

The high energy electron flux (greater than 2MeV at GOES16) is expected to show a similar diurnal oscillation in the near-term, becoming attentuated at GEO for a time from geomagnetic activity from CH33/+. There is then a Chance of 24-hour integrated fluence rising to Active as geomagnetic activity eases, but before the possible onset of a second coronal hole - CH34/- around midweek.

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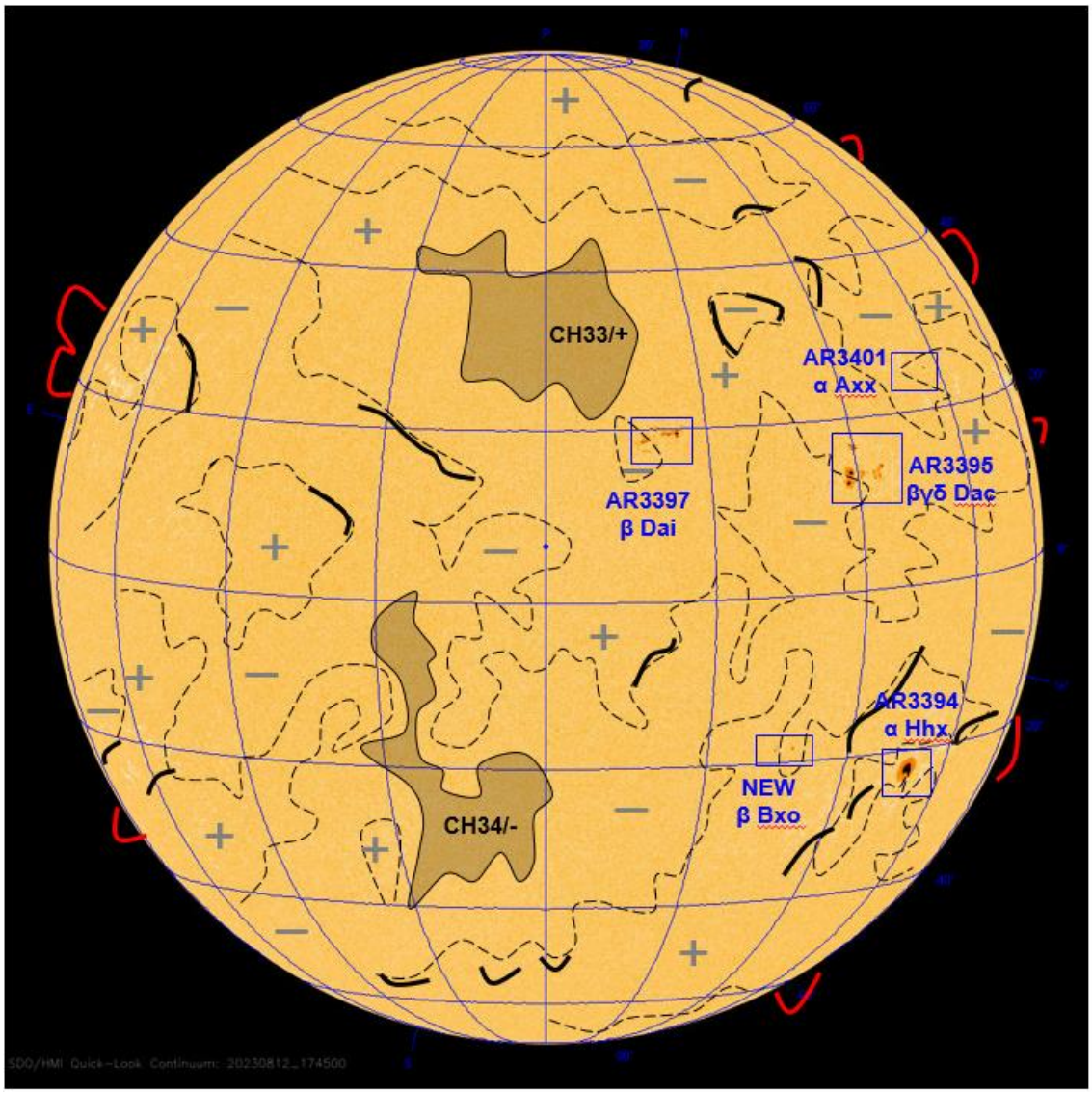
Figure 1. Solar Analysis Valid 12/1745UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

No Earth-directed CMEs feature in this forecast.

The main fast wind source to feature in the forecast period is that from CH33/+, now just west of the solar meridian in the northern hemisphere. While this feature was present in some form on the previous rotation, it is now significantly larger and has retrogressed, and is expected to be more intense but relatively slightly later on this occasion as a result. The latest iteration of MOSWOC Enlil has this feature arriving as a marked CIR as early as the end of the current UTC day (Sunday 13 August), before segueing into a peak wind speed of around 500km/s. This fast wind is felt to be proposed a little early for its visible location on the disc, with a more likely arrival on day 2, (Monday 14 August), then giving a peak Chance of G1 for the period.

Should the fast wind arrive later on Monday, there is a Slight Chance of G1 continuing into day

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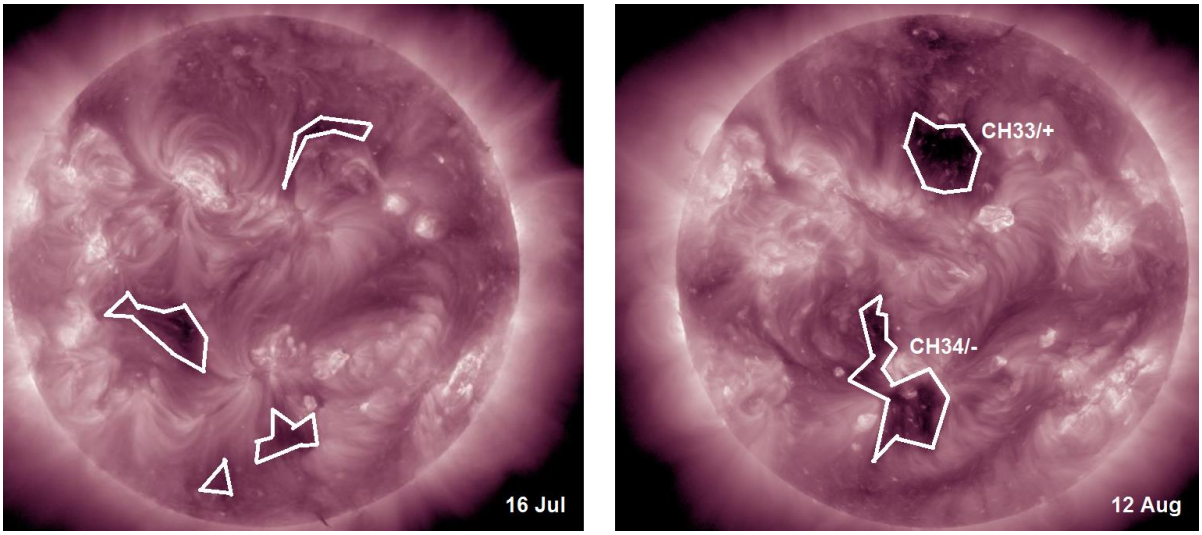
three, Tuesday 15 August. There should then follow a brief lull before a possible second fast wind becomes geoeffective - that from CH34/-, a visibly less marked equatorial coronal hole. The polarity of this feature should lessen the chance of any resurgence to G1, however a second peak in risk in a 20% Slight Chance of G1 is suggested for the end of the UTC day of Wednesday 16 August, before more decidedly tailing off to end the upcoming UTC working week.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	50	10	20
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Nil.

Figure 2: SDO AIA211 imagery from the previous and current rotations, showing geometry and positional changes in CH33/+ especially. Its larger and more intense manifestation as well as our relatively nearer position to the equinox mean that G1 is considered more likely on this occasion. Equatorial CH34/- should round out the upcoming four-day period, albeit probably with lesser intensity and impact.



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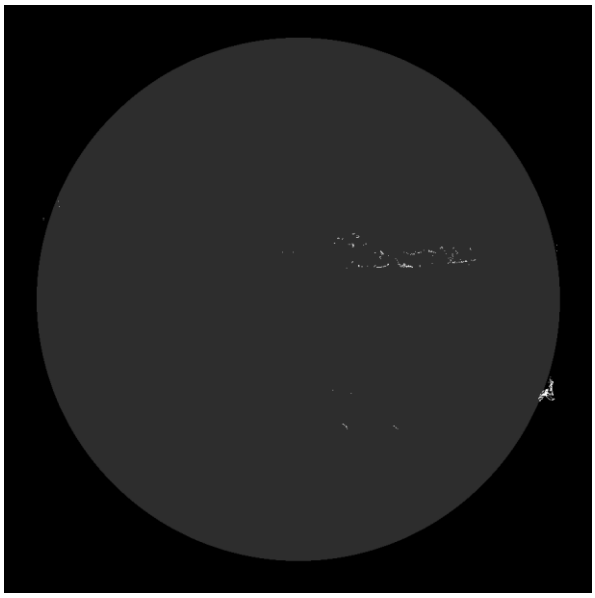
Radio Blackouts - X-Ray Flares:

The current Earth-facing disc has shown more nominal threat in the Zurich class of the few front-sided groups rather than in actuality, as AR3395 in particular has failed to deliver despite its Dac/Beta-Gamma-Delta classification. This sunspot region is now showing signs of simplification including overall areal decay. Despite its recent history and its fading trend, it remains the most liable to flare significantly - on paper - and it would take very little change in its constituent deltas to see this group spark into life. This region is responsible for the bulk of the daily Chance of M-class X-ray flares, but with a now-increasing contribution from AR3397 to its east, which is now showing as a Dai/Beta. AR3394 has recently become unipolar, but it has undergone previous spot proliferation around this main penumbra in its journey across the disc, and similar could again occur as it nears the limb.

On balance, up to two of the above regions depart the disc by the very end of the four-day period, leading to a slight reduction around this time in the M-class risk. Any mitigation from the eastern limb far side is as yet unascertained, however soundings do suggest some northern hemisphere groups could lie in wait to slow or even reverse any improvement in radio blackout risk - to be determined as they present over the limb.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	No	40	40	40	30
Very Active	R3 to R5 X Class	No	5	5	5	1

Figure 3: SIDC ROB visualisation of the emission locations of C-class flares and above in the past 72 hours – AR3395 can be seen to be predominant, even if these have yet to reach M-class.



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Solar Radiation Storms - (High Energy Protons):

The flux of high energy (greater than 10 MeV) is well below the S1 Minor Storm level and easing, but remains slightly above Background after the S1 enhancement on 08 August.

There remains a daily Slight Chance of further enhancements - mainly due to any notable flares from AR3395 in the northwest, although this spot group has no history of such. The risk should increase very slightly with the westward progression of the current front-sided cohort, peaking around midweek before beginning to wane once again.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

The high energy (greater than 2 MeV) electron flux has shown a slight day-on-day reduction in the last 24 hours in the prevailing relatively mild fast wind environment (from an unidentified source). Similar diurnal flux levels are expected in the near-term, with the next major change due to the CIR and CH33's arrival, probably within the UTC day of Monday 14 August. After the initial compression from the increased geomagnetic activity, there is a Chance of 24-hour integrated fluence rising to become Active at GEO, and although this is more likely to occur than on last pass given CH33's greater intensity, the window for this to occur is considered likely to be brief, as a second coronal hole may again compress the Van Allen belt and perhaps redistribute any gains to mitigate against large magnitude late-week rises in fluence.

MOSWOC REFM has hints of a rise in its forecast trend, as well as displaying the step-wise upward change from persistence, however given the detail of CH33 has changed, the onset and magnitude of this signalled increase is low confidence. REFM's 72-hour range does not yet have the scope to provide any information surrounding any second fast wind enhancement.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	10	30
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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Figure 4: Last three days in GOES16 high energy electron flux (top) and 24-hour integrated fluence (bottom blue trace). MOSWOC REFM's forecast (white) is perhaps a little out of phase and may not have captured the full expected intensity of the upcoming fast wind's enhancement. The step-wise change in the past rotation's fluence shown (yellow) is expected to arrive later on this pass and perhaps be larger in magnitude.

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